

APPARATUS FOR MOVING A MEASURING DEVICE ALONG A PIPE

The invention concerns an apparatus for displacing a measurement device along a pipe. More specifically, the invention proposes an apparatus for displacing a measurement device that, for example, is used to measure the thickness of the pipe.

In the international application No. WO 0196808 (LAVOIE) published December 20, 2001, a bracelet enabling, for example, the measurement of the thickness of reactor supply pipes (RSP) for CANDU 6 type nuclear power plants is shown. The bracelet in question is composed of an aluminium frame for retaining a flexible ring attachment provided with fourteen ultrasonic sensors. The bracelet enables the manual inspection of the first and second elbowed sections of the supply pipes, where the majority of imperfections are found. Nevertheless, this bracelet presents the inconvenience that it must be manually placed on the pipe, thus limiting its range of action to the length of the operator's arm. Thus, this bracelet does not enable a complete study of the state of wear of the reactor pipes, inasmuch as it is not able to obtain the necessary information on the thickness of the pipes that are inaccessible to the operator.

Furthermore, the American patent No. 5,420,427 (MORGAN et al.) shows an apparatus for inspecting pipes that comprises a bracelet equipped with a motorisation device for displacing the bracelet over a limited section of the pipe and for rotatively displacing the probes disposed around the bracelet. The motorisation system of the bracelet along the pipe is composed of a threaded rod rotatively driven by a gear coupled to a motor. The bracelet is mounted on the threaded rod according to a carriage principle and is thusly displaced along the pipe. The principle requires that the threaded rod and its support be installed beforehand on the segment of limited mobility of the bracelet, and is in no way adapted for displacing a bracelet along an elbow or in a place that is manually inaccessible.

The American patents No. 4,611,170 and 4,555,665 (STANLEY et al.) show the displacement of a device along a tubular structure by simple pulling with the help of a cord attached to the device to be displaced along the pipe and wound at the other end around a drum or pulley of a stationary transducer. The pulley system proposed by STANLEY et al. faces the same problems as the system proposed by MORGAN et al.

The American patent No. 5,963,030 (STARK) shows an apparatus for inspecting a pipe composed of a bracelet that is manually centered and displaced along the pipe on rollers.

- 10 The American patent No. 4,375,165 (DE STERKE) shows a system for inspecting joints in pipelines. The inspection device is suspended from a rail disposed above the pipe to be inspected.

There also exist additional American patents that describe different inspection devices, and they have the following numbers: 4,485,344; 4,607,925; 15 4,843,884; 5,313,837; 4,879,973; 5,577,088; 5,585,565; 5,591,925; 5,594,162; 5,962,762; 6,000,288 and 6,003,377.

None of the above-mentioned devices enables the inspection of pipes along sections of pipes that are bent or which are situated in locations that are beyond the reach of the arm of an operator who is performing the inspection.

- 20 An objective of the present invention is to propose an apparatus for displacing a measurement device along a pipe that overcomes the different inconveniences mentioned hereabove.

The present invention concerns an apparatus for displacing a measurement device along a pipe, comprising a bracelet having two extremities provided with closing means for closing the bracelet around the pipe; supporting means for 25 supporting the measurement device in relation to the bracelet; at least one drive

wheel each having an axis, mounted on the bracelet and oriented for displacing the bracelet along the pipe; flexible transmission means having an inlet for receiving a rotational movement and an outlet for transmitting the rotational movement; gear means mounted on the bracelet for reorientating the rotational movement coming from the outlet of the flexible transmission means towards the axis of the wheel; and coupling means for coupling the gear means to the axis of the wheel.

The present invention also concerns an apparatus for displacing a measurement bracelet along a pipe, comprising at least one drive wheel each having an axis, mounted on the bracelet and oriented for displacing the bracelet along the pipe; flexible transmission means having an inlet for receiving a rotational movement and an outlet for transmitting the rotational movement; gear means for reorienting the rotational movement coming from the outlet of the flexible transmission means towards the axis of the wheel; and coupling means for coupling the gear means to the axis of the wheel.

The objects, advantages and other characteristics of the present invention will become clear in the non limiting description that follows with preferred embodiments, while making reference to the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

- 20 Figure 1 is a perspective view of a preferred embodiment of the invention;
- Figure 2 is a perspective view of a part of the preferred embodiment shown in figure 1;
- Figure 3 is a perspective view of a part of the preferred embodiment shown in figure 1; and
- 25 Figure 4 is a perspective view of a part of the preferred embodiment shown in figure 1.

DETAILED DESCRIPTION OF THE DRAWINGS

In the different figures of the drawings, the corresponding elements are identified by the same numeric references.

Referring to figures 1 to 4, the apparatus according to the present invention is for
5 displacing a measurement device along a pipe (not shown). The apparatus
comprises a bracelet 4 that is shown in more detail in figure 3. The bracelet has
two extremities provided with closing means for closing the bracelet 4 around the
pipe. Preferably, the bracelet comprises two parts 6 and 8 in the form of half
circles. The two parts 6 and 8 have first extremities connected by a pivot axis 10
10 and second free extremities on which the closing means is disposed. The pivot
axis 10 enables the two parts to open to be installed around the pipe and then be
closed for being fixed around the pipe by the closing means. Preferably, the
closing means comprise a hook-shaped element 12 mounted on one of the
second extremities of the bracelet, and a rod 14 mounted on the other second
15 extremity and able to cooperate with the hook-shaped element 12 for closing the
bracelet around the pipe.

The apparatus also comprises supporting means for supporting the
measurement device in relation to the bracelet 4. Of course, different
measurement devices can be mounted in relation to the bracelet. In the present
20 case, ultrasonic sensors (not shown) similar to those shown in the international
application No. WO 0196808 (LAVOIE) can be mounted on the body of the
bracelet. In this case, a coupling diffuser for coupling 17 is provided for
cooperating with the ultrasonic sensors. The supporting means for supporting the
measurement device preferably comprises, therefore, in the present case, a
25 support arm 28 for supporting a part of the measurement device, such as the
coupling diffuser, in relation to the bracelet.

The apparatus also comprises at least one drive wheel. Each drive wheel has an
axis. Each wheel is mounted on the bracelet and oriented for displacing the

bracelet along the pipe. Preferably, several drive wheels are provided and the apparatus furthermore comprises at least one free wheel oriented in the same manner as the drive wheels. In the context of the present application, free wheel indicates a wheel that is not connected to driving means.

- 5 The free and drive wheels are regularly distributed along the bracelet. Still preferably, the drive wheels are grouped in first and second pairs of wheels 18 and 20, and the free wheels are grouped in a third pair of wheels 22. each of the pairs of wheels has its wheels distributed according to a longitudinal axis of the pipe, as can be seen in figure 3. The pairs of wheels are distributed regularly
10 along the bracelet. Still preferably, each of the drive wheels takes the form of a roller on which two tires 24 are mounted. A single drive wheel can be sufficient for driving the bracelet along the pipe. The free wheels can be replaced by non mobile elements that slide along the pipe.

- 15 The apparatus comprises flexible transmission means having an inlet for receiving a rotational movement and an outlet for transmitting this rotational movement. Preferably, these flexible transmission means comprise a first primary flexible transmission shaft 26 having an inlet for receiving the rotational movement and an outlet supported by the support arm 28 of the bracelet 4. Still preferably, the flexible transmission means also comprise a second primary
20 flexible transmission shaft 30 for connecting the outlet of the first primary flexible transmission shaft 26 to gear means. The apparatus therefore comprises these gear means which are mounted on the bracelet for reorienting the rotational movement coming from the outlet of the flexible transmission means towards the axes of the drive wheels. Preferably, these gear means comprise first and
25 second gears 32 and 34 for respectively driving the wheels of the first and second pairs of wheels 18 and 20 via coupling means. The first gear 32 has an inlet for receiving the outlet of the second primary flexible transmission shaft 30 and an outlet for driving the second gear 34 by means of a flexible transmission shaft 36.

The apparatus comprises the coupling means mentioned hereinabove for coupling the gear means to the axes of the drive wheels. These coupling means comprise secondary flexible transmission shafts 40 for driving the first and second pairs of drive wheels 18 and 20. Furthermore, the apparatus may
5 comprise a motor 42 attached to the transmission means for producing the rotational movement.

Preferably, the apparatus further comprises visual inspection means comprising a light 46, a camera 48 and an encoder 44, mounted to a chassis, and a support arm 16 for mounting the chassis in relation to the bracelet. The visual inspection
10 means enables the inspection of the pipe by the apparatus operator. The support arm 16 has a first part fixed to the second gear 34, and a second part on which the chassis of the visual inspection means is fixed.

According to another preferred embodiment of the invention, the apparatus is adapted for displacing a measurement bracelet along a pipe. In this case, the
15 apparatus comprises at least one drive wheel, flexible transmission means for transmitting the rotational movement, gear means for reorienting the rotational movement coming from the flexible transmission means towards the axis of the drive wheel, and coupling means for coupling the gear means to the axis of the drive wheel. The apparatus according to the present invention enables the
20 displacement of a bracelet in a motorized fashion along a pipe and even along an elbow of this pipe.

An umbilical cord enables the connection of the different elements mounted on the ring attachment to measurement apparatuses. The first primary flexible transmission shaft 26 has a centered position, which enables it to be integrated
25 in the umbilical cord, which also contains the coupling power supply, the wire for the encoder and the wires for the ultrasonic sensors.

The dimensions of the apparatus are chosen in accordance with the size of the RSPs to be examined. The apparatus is preferably thin for enabling its passage

in constrained places (i.e. tight or limited spaces). The closing means of the bracelet can be advantageously activated from a distance. The tires enable better traction. Instead of being equipped with tires, the wheels can be entirely made of rubber or another traction aiding material. The free wheels serve as support wheels.

Preferably, the motor 42 is an in-line motor "floating" in the umbilical cord, that is to say, that the motor is integrated in the umbilical cord which connects a control and command case (not shown) to the bracelet which depends thereon. The fastening of the motor 42 to the sheath of the umbilical cord, which is itself fixed to the bracelet (i.e. by means of the diffuser 17 and the support arm 28), advantageously contributes to the appropriate maintenance of the motor 42 so that it efficiently drives the primary transmission shaft 26 without having to be otherwise fixed, for example, to an external structure of the apparatus. Such an assembly notably enables the motor 42 to follow the displacement of the bracelet. Other assemblies can however be realized if desired. The driving of the wheels is done by primary flexible shafts 26 and 30 coupled between the motor and the secondary flexible shafts 40 on each side of the bracelet. The encoder 44 is a proximity detector encoder. The diffuser 17 for coupling is integrated into the assembly. The distance between the diffuser 17 and the ring assembly is constant. As a security measure, a steel wire can be fixed to the bracelet for enabling it to be taken back in the eventuality that the apparatus is subject to a malfunction.

Although the present invention has been explained hereinabove by way of a preferred embodiment thereof, it would be understood by someone skilled in the art that the invention is not limited to this precise embodiment and that various changes and modifications may be effected therein without departing from the scope or spirit of the invention.